

Office of Technical Assistance Research Proposal
Development of Non-Formaldehyde Cross-linking Agent

BACKGROUND:

Crosslinking is used to make various types of fabric heat, stress, and wrinkle resistant. The wrinkling or creasing of cotton fabric occurs as a result of polymer chain slippage under moist conditions. As a result, chains are cross-linked to prevent chain slippage, hence improving a fabric's wrinkle resistance. Formaldehyde and formaldehyde derivatives were among the earliest cross-linking agents discovered, and are still the most widely used in the textile finishing process. DMDHEU (dimethyl-4,5-dihydroxyethylene urea), based on the reaction of formaldehyde, urea, and glyoxal, accounts for approximately 85 % of the wrinkle resistant chemicals used today.

Formaldehyde has long been identified as a hazardous chemical. The EPA has classified formaldehyde as a probable human carcinogen (Group B1). Reproductive effects, such as menstrual disorders and pregnancy problems, have been reported in female workers exposed to formaldehyde. Formaldehyde has also been identified as an eye, mucous membrane, and skin irritant, and well as is highly flammable. For these reasons, OSHA has lowered worker exposure to airborne formaldehyde to 0.75 ppm over an 8-hour time weighted period. In addition, the Science Advisory Board for the Toxics Use Reduction Institute has recently identified formaldehyde as one of thirty-eight Category I "More Hazardous" substances.

An additional area of concern with the use of formaldehyde as a crosslinking agent is the emanation of formaldehyde from finished fabrics. Because concentrations as low as 300 mg formaldehyde/kg of garment can trigger allergic effects in sensitized persons, the level of formaldehyde emissions into the air from textile materials (e.g. carpets, mattresses, upholstery) has been limited to 0.1 mg/m³. Thus incorrect use or application of formaldehyde during the finishing process can lead to both worker and consumer hazard.

Because of the hazardous nature of formaldehyde, much research has been conducted on the reduction of worker and consumer risk in this area. The majority of the research conducted has concentrated on the fabrication of methods to reduce the amount of formaldehyde released. This has been done through the use of engineering controls, the addition of supplementary substances, scavengers, to react with the formaldehyde, and the modification of DMDHEU to result in a lower use or release of formaldehyde. A well-known example of modified DMDHEU is diethyleneglycolated DMDHEU, commonly referred to as ULF, ultra low formaldehyde. ULF has low formaldehyde release and is used by some textile finishers.

SCOPE OF PROBLEM:

Because formaldehyde and formaldehyde derivatives are still the most widely used crosslinking agents in the textile industry, this research would have a clear benefit for the textile industry, particularly for the production workers dealing with formaldehyde. It is difficult to determine the extent of use of formaldehyde in Massachusetts due to the fact

that most facilities that use formaldehyde do not use it in thresholds reportable under TURA. One textile facility reports formaldehyde usage under TURA. OTA has visited two companies that currently use formaldehyde under the TURA threshold limits, one of which has expressed interest in becoming an industry partner for this research. We suspect that there are several other companies using formaldehyde as a crosslinking agent.

OBJECTIVE:

The objective of this project is to develop a practical non-formaldehyde crosslinking agent that can be used in the textile and apparel industries. Dr. Samuel Ugbolue of UMass Dartmouth worked on this project during the fiscal year 2000. During this time, experiments were conducted on the use of a modified acrylic copolymer emulsion as a crosslinking agent. This non-formaldehyde resin was found to provide wrinkle resistance, shrinkage control, and stability to cellulosic fabrics. This research should be continued so that commercialization potential can be determined.

SCOPE OF WORK:

The investigation of the above-mentioned resin as well as other non-formaldehyde alternatives should be continued. The treated fabrics should be subject to after-washing and other typical industrial finishing processes, and then tested for durability and wrinkle resistance. The thermal characteristics, crosslink density, and characterization of the molecular state of the products should also be determined using FTIR and NMR.

One specific company has expressed interest in acting as an industry partner for this research.